

A TECHNIC PERMITTING OPERATION UPON SMALL ARTERIES *

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Atherosclerotic occlusive lesions occurring in small arteries, namely, coronary, renal, vertebral, internal carotid, femoral, and popliteal arteries, are frequently well localized to a short segment of the involved vessel. This fortunate pathologic feature of the disease process theoretically permits direct attack on the occlusive lesion aimed at restoration of normal circulation. Despite the successful application of endarterectomy and tubular graft operations in many of these cases, the functional results of these procedures in the treatment of lesions occurring in small arteries have not been as satisfactory as when applied in the treatment of similar lesions occurring in the aorta and iliac arteries. The major limiting factor in the application of these procedures to small arteries has been lumen constriction resulting from arterial repair.

Theoretically, endarterectomy is the ideal operation to be employed in the treatment of small vessel lesions because of the discrete nature of the occlusive process and the simplicity of the operative procedure. Moreover, the brief period of temporary occlusion required for its performance is particularly advantageous in the treatment of lesions involving vessels which cannot be occluded indefinitely during operations, namely, the coronary, internal carotid, vertebral, and renal arteries. The purpose of this study was to perfect the technic of endarterectomy by devising a method of arterial repair which would not be associated with lumen constriction. This report is concerned with various methods of arterial repair employed in the laboratory and a review of the clinical application of one of these methods in the treatment of 93 lesions occurring in the internal carotid, vertebral, renal, femoral, subclavian, and popliteal arteries and the aorta.

MATERIALS AND METHODS

Experimental. The femoral arteries of 16 mongrel dogs weighing approximately 12 kg. were exposed under intravenous nembutal anesthesia. A longitudinal incision was made in the right femoral artery in all animals. A transverse incision was made in the lateral half of the circumference of the left femoral artery in 8 dogs and in the other 8 animals a longitudinal incision was made in the femoral artery on the left. Fine atraumatic no. 000000 arterial silk sutures were employed. In one group of 4 animals the longitudinal incision on the right and transverse incision on the left were closed with multiple closely placed interrupted sutures (Fig. 1-2). In a second group of 4 dogs the longitudinal incision on the right and the transverse incision on the left were closed with a continuous over and over suture. In the remaining 8 dogs the longitudinal incision on the right was closed with a continuous over and over suture and the longitudinal incision on the left was closed by inserting a knitted dacron patch into the arterial wound. In the latter cases the edges of the arterial incision were sutured circumferentially to the edges of the patch

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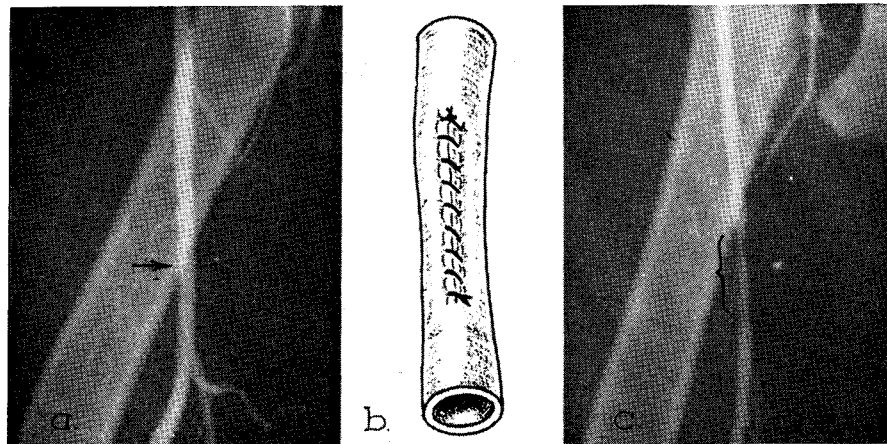


Fig. 1. a. Femoral arteriogram made before operation.
b. Diagram of operation (longitudinal incision).
c. Femoral arteriogram made after operation showing constriction.

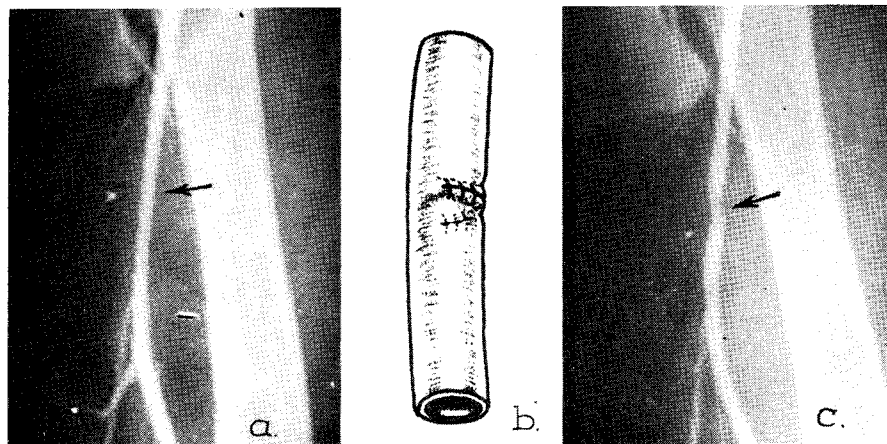


Fig. 2. a. Femoral arteriogram made before operation.
b. Diagram of operation (transverse incision).
c. Femoral arteriogram made after operation showing constriction.

graft employing a continuous over and over suture (Fig. 3-4). Arteriograms performed by injecting 30 cc. of 50 per cent hypaque solution into the aorta were obtained immediately before and after operation and one month following operation. The incidence and degree of arterial constriction were determined in each artery and the various methods of arterial repair were compared.

The circumflex branch of the left coronary artery was exposed in 10 dogs under intravenous luminal anesthesia. The dogs were then given heparin, two milligrams of heparin per kilogram body weight. A longitudinal incision was made in the circumflex branch of the left coronary artery. A small polyethylene tube was inserted into the coronary artery to provide circulation while a fresh autogenous arterial patch graft was inserted to close the wound. The

shunt was withdrawn just before the last suture was drawn taut. Protamine sulfate, two milligrams per kilogram body weight, was then given. Coronary arteriograms were performed one month after operation by injecting 30 cc. of 50 per cent hypaque solution into the ascending aorta (Fig. 5).

Clinical. A group of 93 patients with the clinical manifestations of arterial insufficiency were studied arteriographically and were found to have occlusive lesions localized to the internal carotid artery in 52, vertebral artery in 7, subclavian in one, renal in one, femoral in 16, the popliteal artery in 13 and the aorta in 3 cases. These patients were submitted to thromboendarterectomy and patch graft closure of the arterial incision. A longitudinal incision was made through the diseased arterial segment completely exposing the occluding lesion as well as a short segment of uninvolved artery both proximal and distal to the lesion. With the wound edges retracted the obstruction was accurately removed under direct vision without leaving elevated intima which could dissect distally. The arterial incision was repaired by inserting a knitted dacron patch graft. Two no. 000000 atraumatic arterial sutures were used to suture the edges of the patch to the arterial wound circumferentially. Internal shunts were employed as previously described in the treatment of 33 lesions of the internal carotid artery and 6 lesions of the vertebral artery.

RESULTS

Experimental. Luminal constriction of some degree occurred immediately in all instances in which either a transverse or longitudinal arterial incision was repaired by opposing the wound edges regardless of the type of suture technic employed (Fig. 1-2). This constriction persisted for the duration of the experiment. In contrast to these results, luminal narrowing did not occur in any experiment in which a longitudinal incision of the femoral artery was closed by inserting a patch graft; in fact, the circumference of the artery in the

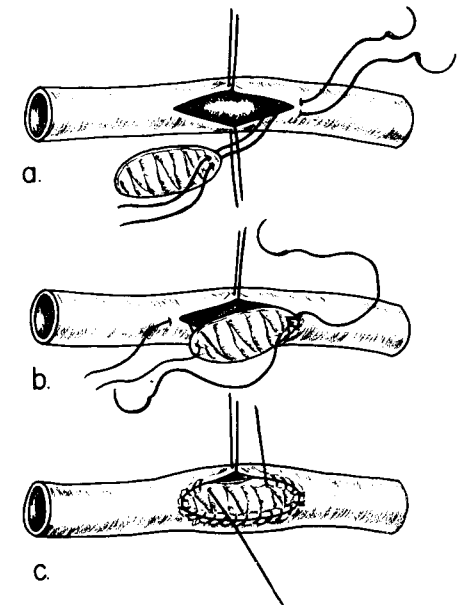


Fig. 3. Illustrations showing application of patch graft.

- a. Longitudinal incision and patch.
- b. Method of inserting patch.
- c. Patch graft in place.

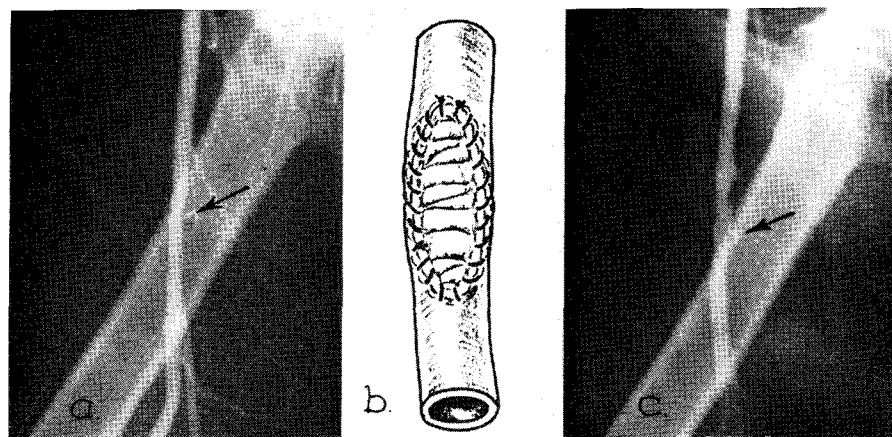


Fig. 4. a. Femoral arteriogram made before operation.
b. Diagram of operation (patch graft).
c. Femoral arteriogram made after operation showing no constriction.

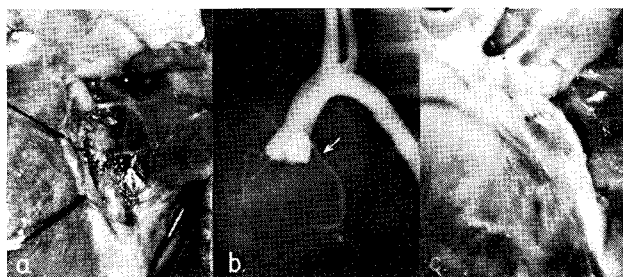


Fig. 5. Illustrations using patch graft in coronary artery.
a. Photograph showing patch graft in place.
b. Arteriogram made one month after operation showing good arterial lumen.
c. Photograph of specimen one month after operation showing patch in place.

region of operation was frequently increased (Fig. 4). All animals in which the circumflex branch of the left coronary artery was incised and closed with a patch graft employing a temporary internal shunt survived operation without fibrillation. All except 4 of these vessels remained patent until sacrificed up to 30 days after operation (Fig. 5).

Clinical. Operation was successful in all 93 patients in whom endarterectomy was performed employing a longitudinal incision and patch graft closure. There were no instances of recurrent occlusion during the period of hospital convalescence and only two patients have had recurrence of obstruction after leaving the hospital although some of these cases have been followed for 30 months.

DISCUSSION

In our experience, both experimental and clinical, the usual methods of repairing arterial wounds regardless of type frequently produce lumen constriction because a part of the circumference of the arterial wall is consumed within

the line of suture. In small arteries, reduction in lumen size assumes great functional significance since the resulting constriction frequently leads to thrombosis. This is particularly undesirable in the treatment of patients with partial occlusion of the internal carotid artery manifested by transient attacks because postoperative thrombosis may cause a progression of the clinical problem to complete hemiplegia. Successful restoration of circulation has become so certain with endarterectomy through a longitudinal incision and patch graft closure that any well localized lesion may be submitted to operation without fear of mishap or recurrent occlusion in the early period following operation.

SUMMARY

Various methods of repairing longitudinal and transverse incisions in small arteries were studied experimentally. All methods of repair which brought the wound edges together were associated with narrowing in a large percentage of the cases. A new method of repair was devised which prevented luminal constriction. This consisted of inserting a patch graft into the incision by suturing the wound edges to the edges of a patch graft. This method of repair was employed clinically in the treatment of 93 lesions and circulation was successfully restored in all cases.